# Active Desiccant Module (ADM) for Commercial Packaged Equipment:

## (Product Development and Field Demonstration)


2002 DOE Peer Review: Presented by John Fischer

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# Impact of IAQ Standards on Energy Consumption in Commercial Buildings

- ASHRAE Standard 62: Increases the quantity of outdoor air, delivered continuously, to maintain an acceptable indoor air quality
- Conventional packaged HVAC systems are designed to provide only minimal amounts of outdoor air intermittently (humidity problems)
- Conditioning outdoor air involves primarily latent load (humidity) during peak design

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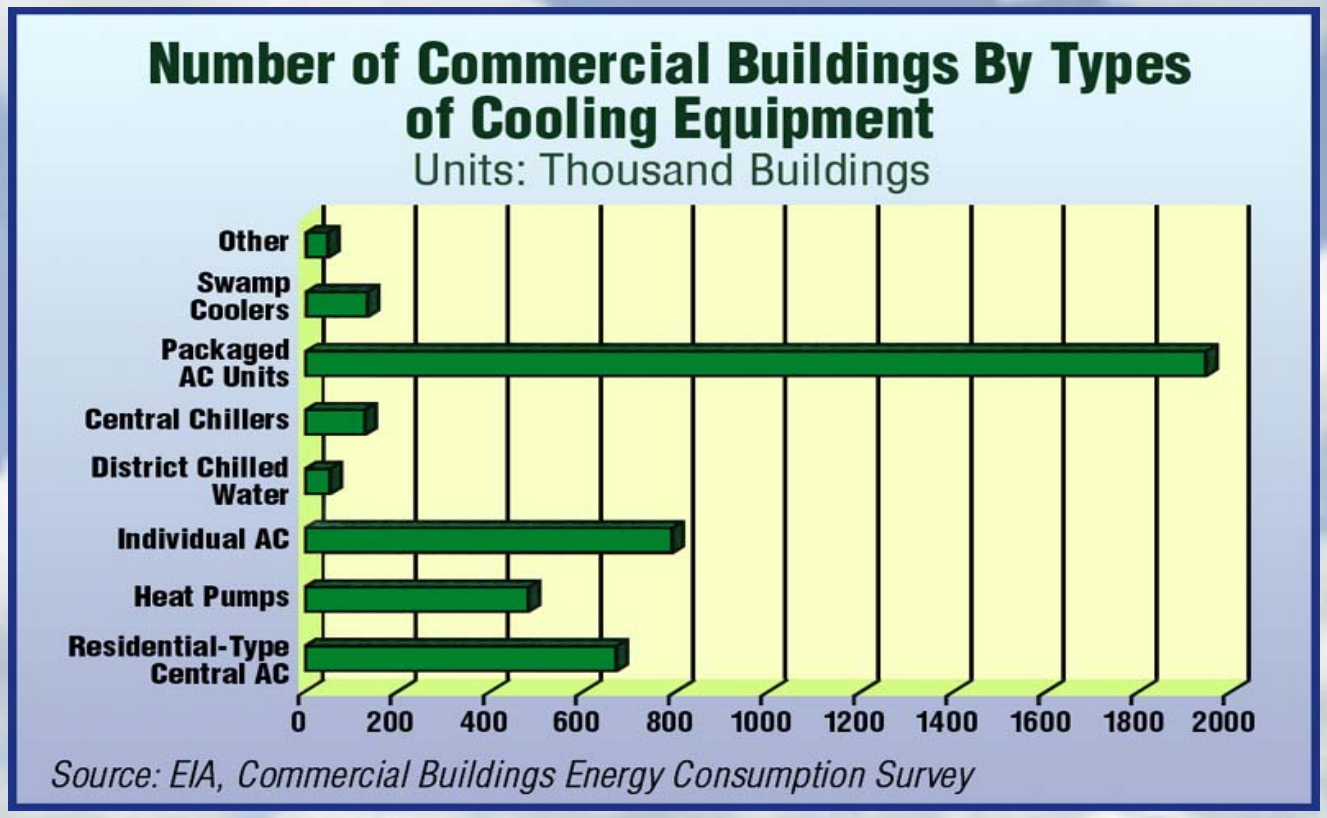
# U.S. HVAC Market is Dominated by Packaged Equipment

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# Over-sizing Packaged Units to Handle Outdoor Air Degrades Latent Capacity

- Moisture condenses on cooling coil surfaces during cooling operation
- When coil (or compressor) is deactivated wet surfaces are exposed to the air stream
- Moisture evaporates back into air stream as the fan continues to run in order to deliver the outdoor air continuously
- Net effect: Less moisture removal & higher space humidity level, lower thermostat setting

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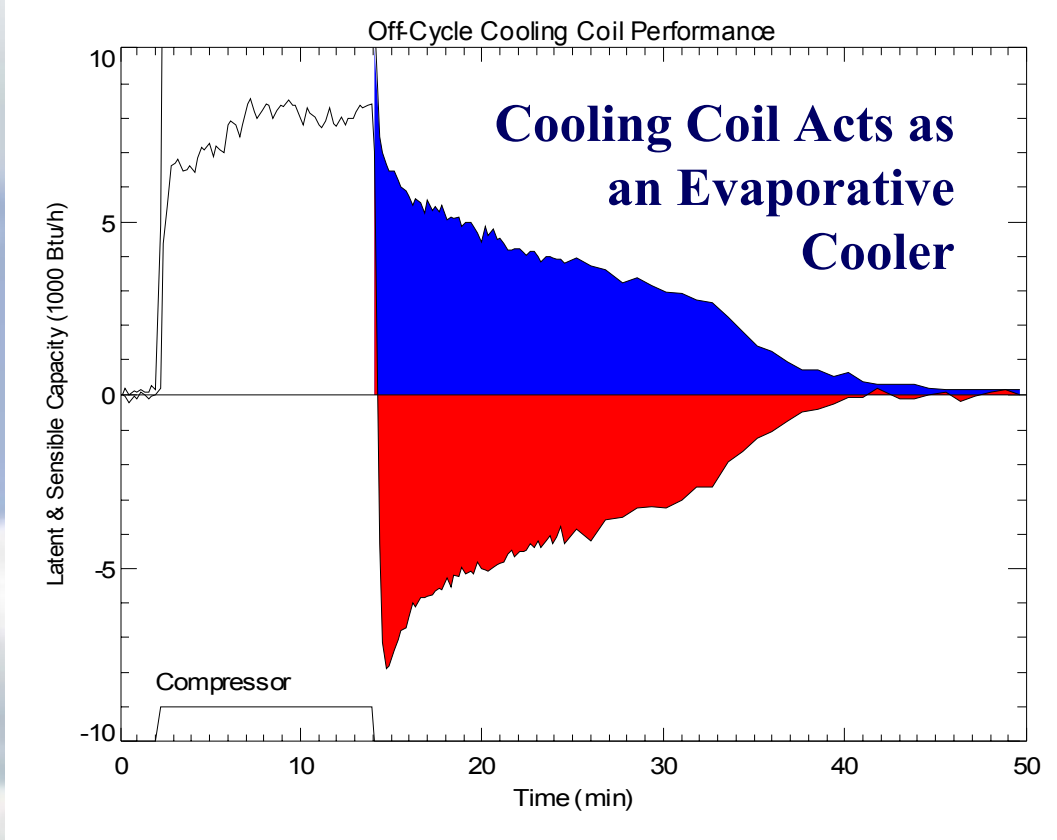
# Excess Sensible Capacity Results in Short Cycle Time and High Space Humidity




Source: Hugh Henderson, 1998 ASHRAE IAQ 98 Paper

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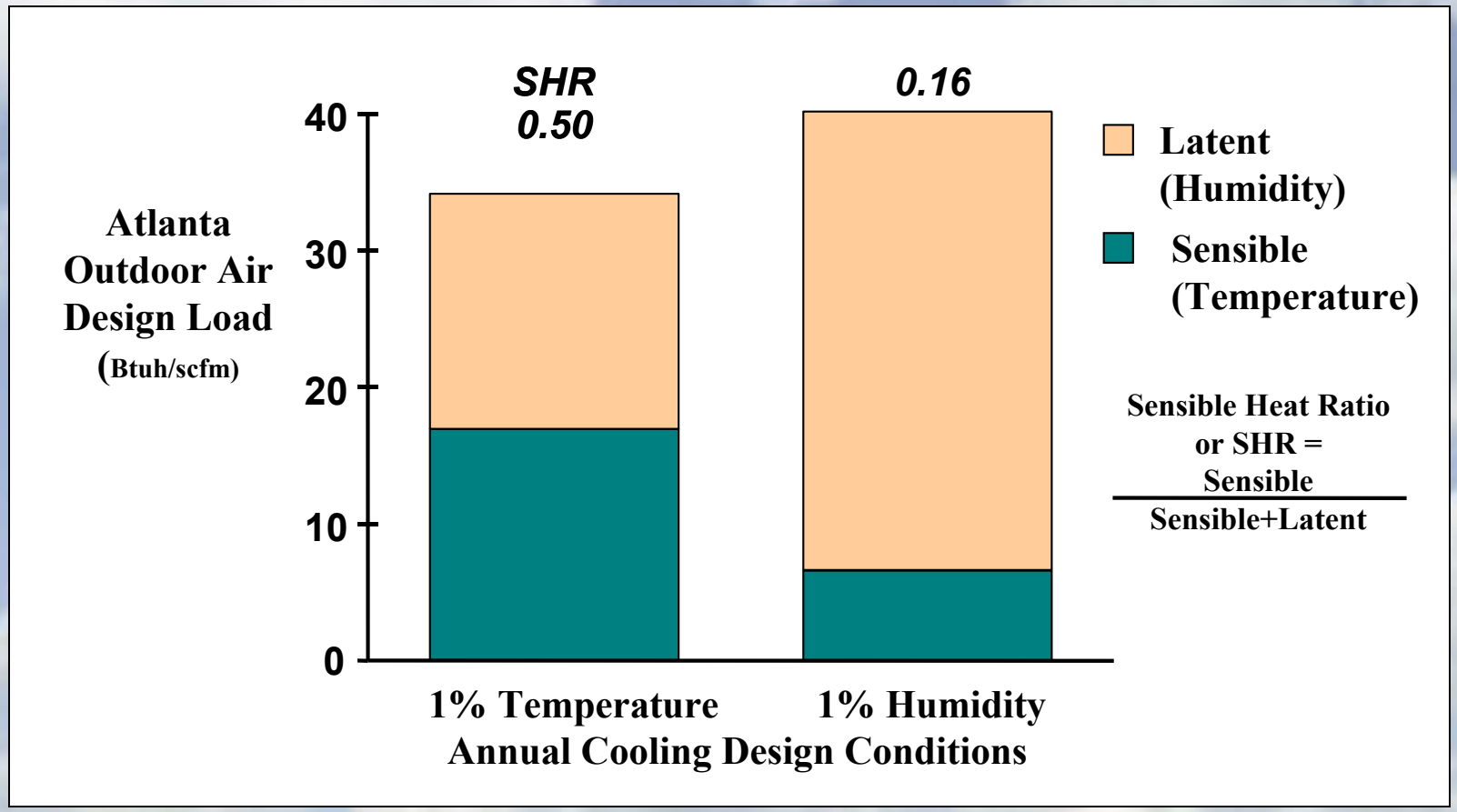
# Outdoor Air: Mostly Latent Load



# Energy Code and IAQ Code: On a Collision Course

- Significant increase in outdoor air quantities will mean huge escalation in energy consumption without new design approaches
- Packaged equipment is currently used for most commercial HVAC systems
- Packaged equipment can not accommodate the increased outdoor air quantities without creating humidity problems or using reheat
- Reheat further increases energy consumption

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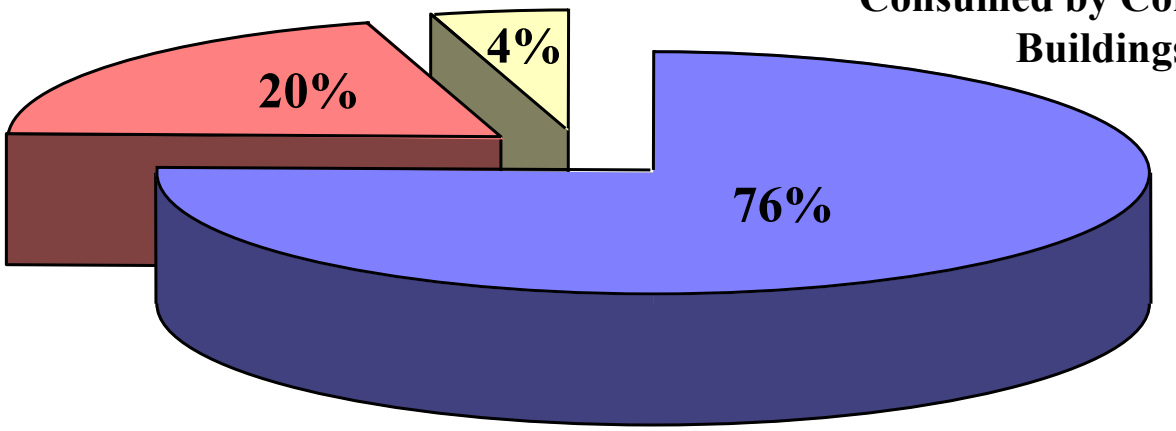
# Energy Impact: Ventilation Air

**Projected Energy Reduction Possible with Active and/or Passive Desiccant Systems by Preconditioning Outdoor Air to Commercial Buildings**




**U.S. Commercial Buildings Energy Consumption Increase Over 10 Years:**

**DOE Projected Base Energy Increase: Years 1990 to 2000 (1.31 Quadrillion BTU)**

SEMCO Phase 1 Report: ORNL/SUB/94-SV044/1

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# The SEMCO ADM Module


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# Phase 1: Product Development

- Detailed analysis to determine market driven need and key performance parameters
- Reviewed current and past design approaches
- Identified “sweet spot” for active desiccant contribution
- Minimized size, first cost and simplified installation procedures
- Maximized control and installation options

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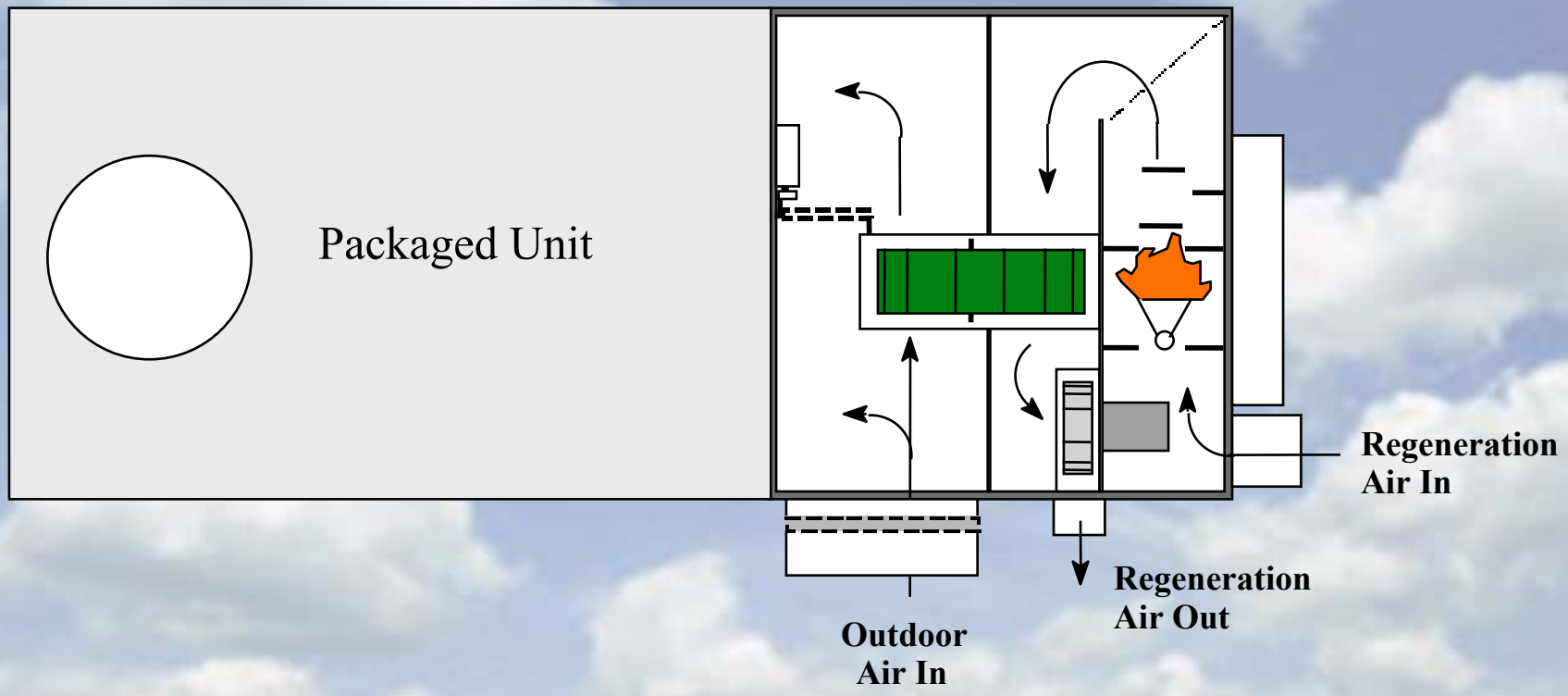
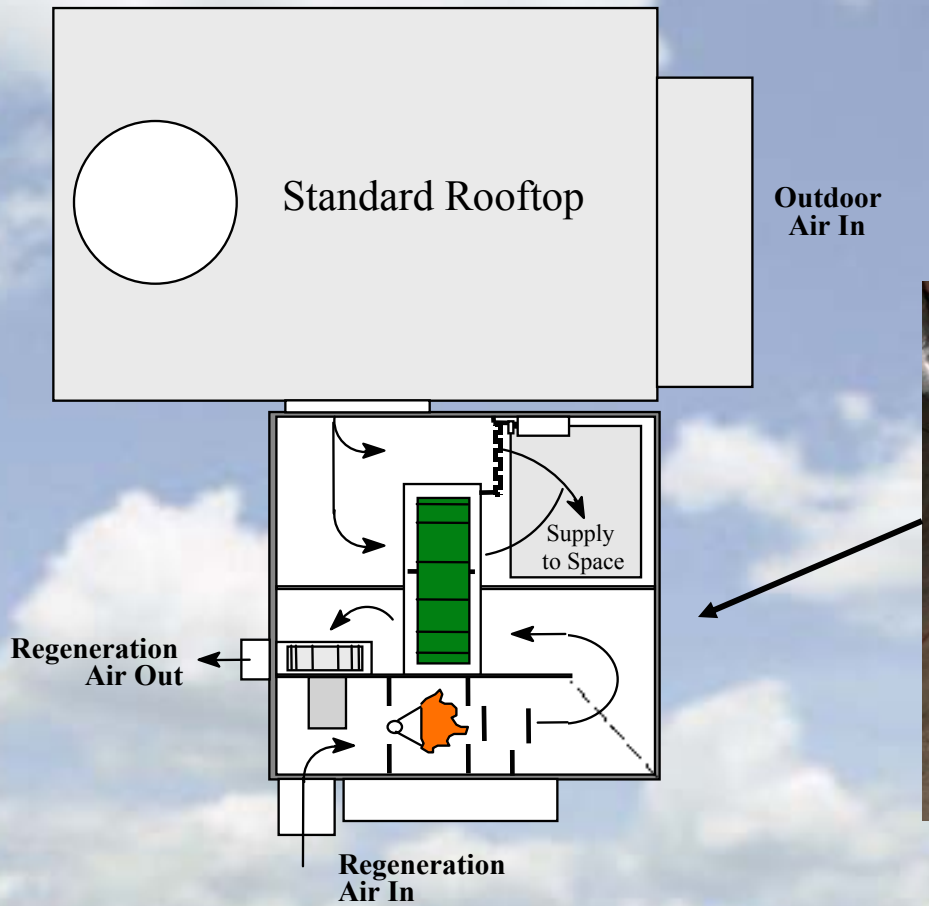
# Previous Active Desiccant Systems Installed Upstream of the Cooling Source



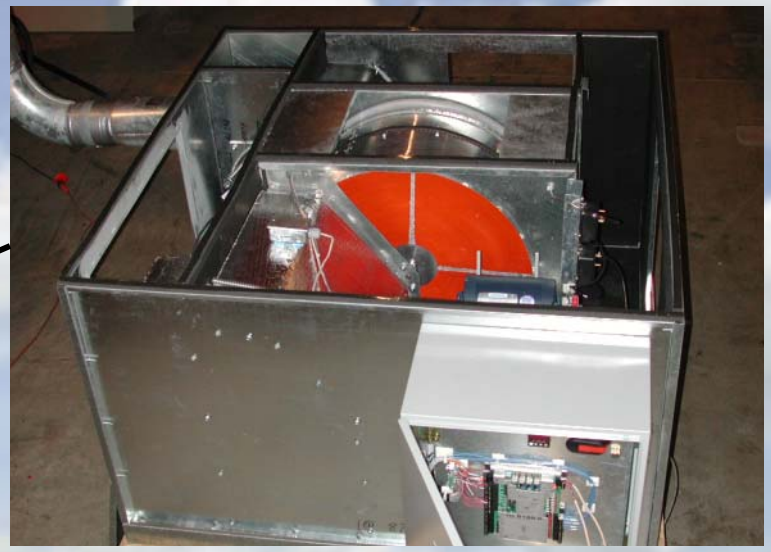
# Results of This Approach

- All of the outdoor air is processed by active desiccant wheel in this arrangement (not sweet spot)
- Large moisture removal required means high regeneration temperatures and low face velocities
- High heat of adsorption requires significant post cooling or second sensible recovery wheel
- Results in a large active desiccant wheel and large overall system with a high manufacturing cost

# ADM Approach Places Active Wheel Downstream of the Cooling Coil




ADM Module



# Advantages of ADM Approach

- Much smaller desiccant wheel processing only 1/3 of the outdoor air stream
- Greatly reduced energy consumption and required regeneration temperature
- Much smaller system to match with existing packaged rooftop equipment, lower cost
- Can produce drier air than other approaches
- More control options

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# Comparing Active Desiccant Approaches

| | ADM Rooftop Combination | Active Desiccant Preconditioning (Note 3) | Traditional DBC Preconditioning (Note 4) |
|---|---|---|---|
| **Cooling Capacity Required (Tons)** | **5 tons** | **8.4 tons** | **2.5 tons** |
| **Air Process by Active Wheel (CFM)**<br>**Regeneration Energy Rqd. (BTU/Hr)** | **540**<br>**33,500** | **1,500**<br>**82,620** | **1,500**<br>**61,480** |
| **Supply Dew Point Used for Analysis** | **56 degree F** | **56 Degrees F** | **56 Degrees F** |
| **Annual Cooling Energy Cost** (Note 1) | **$1,360** | **$2,620** | **$1,560** |
| **Unit Approximated Size (H x W x L)** | **31" x 46" x 46"** | **52" x 66" x 66"** | **52" x 66" x 106"** |
| **Relative Cost of Manufacturing** | **1** | **2.2** | **3** |

Note 3: Excessive heat carry-over degrades energy savings

Note 4: Includes a second sensible only wheel to reduce the cost of operation

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# ADM Advantage Over Customized Packaged Outdoor Air Systems

| | ADM Rooftop Combination | Custom DX Rooftop (over-cool and reheat) |
|---|---|---|
| **Cooling Capacity Required (Tons)** | **5 tons** | **10 tons** |
| **Reheat Energy Required (BTU/Hr)** | **0** | **32,400** |
| **Regeneration Energy Rqd. (BTU/Hr)** | **33,500** | **N/A** |
| **Supply Dew Point Used for Analysis** | **56 degree F** | **56 Degrees F** |
| **Annual Cooling Energy Cost** (Note 1) | **$1,360** | **$2,480** |
| **Unit Approximated Size (H x W x L)** | **31" x 46" x 46"** (note 2) | **50" x 70" x 106"** |

Note 1: Based on a 1,500 cfm outdoor air preconditioning system
Note 2: Plus conventional 5 ton rooftop ( approx. 33” x 46” x 83”)

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# Fully Integrated System Development


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# Full Laboratory Testing:
## (Excellent Example of Industry Partnership)


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# Phase 2: Field Demonstration Sites

- Demonstration Pilot Sites
  - Resort Hotel (Callaway Gardens)
  - Chain Restaurant (Hooters)
- Both sites in operation, fully instrumented with remote monitoring capabilities
- "Virtual Laboratory sites"
- Both retrofit sites, helping existing facilities to resolve serious humidity control problems
- Excellent results to date

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# Fresh, Dry Outdoor Air to Guest Rooms


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# Typical Chain Restaurant Facility


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# Kitchen Open to the Dining Area

# Fresh, Dry Outdoor Air for Kitchen Exhaust Makeup and ETS


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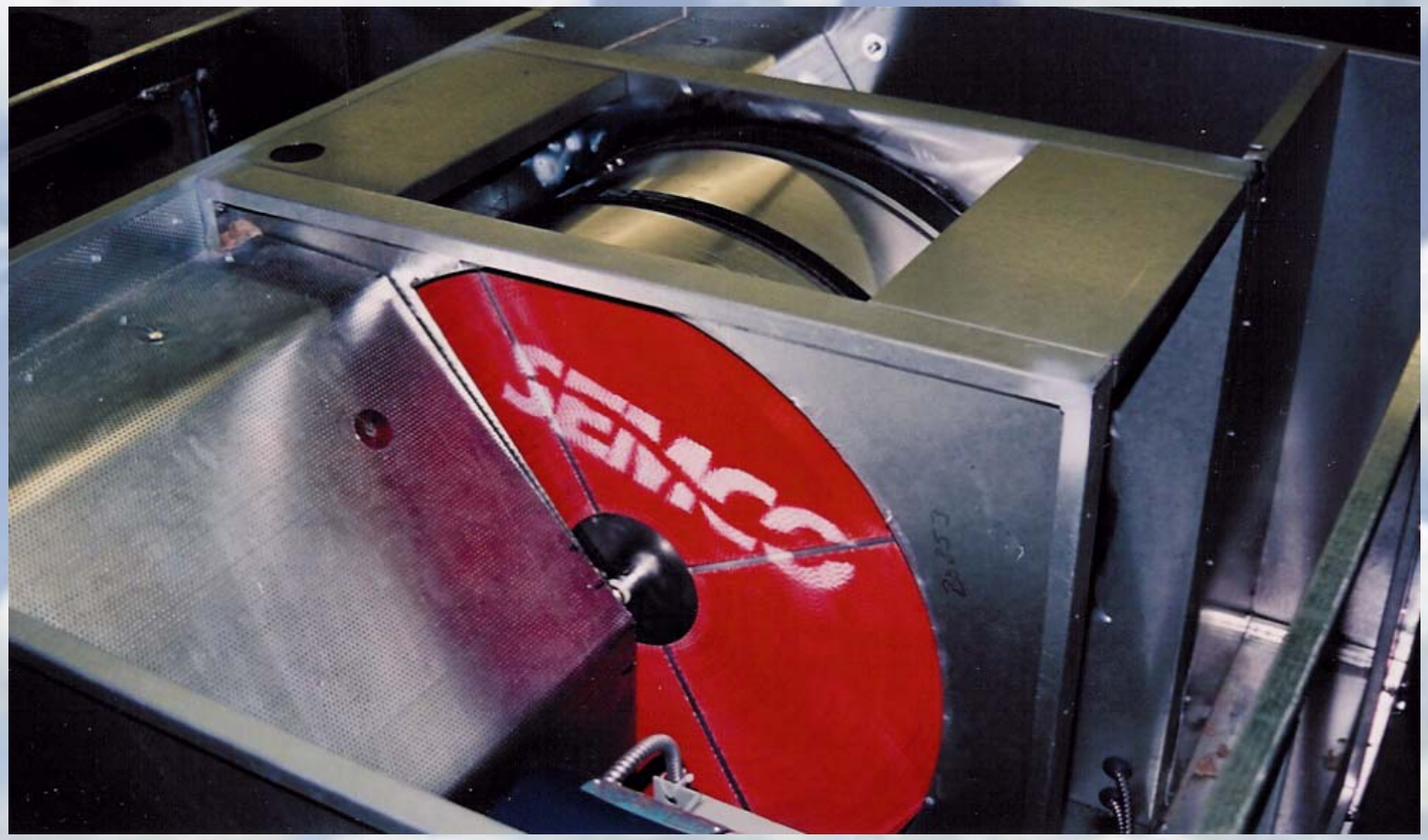
# Active Desiccant Wheel in ADM

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# Key Advantages Offered by ADM

- Reduced cooling tons with increased latent capacity, simplified controls
- Improved humidity control, variable SHR
- Reduced energy consumption – higher thermostat setting at same comfort level
- Lower cost fuel (gas or waste heat) used for dehumidification, “clean technology”
- Dehumidification without compressors during part-load conditions

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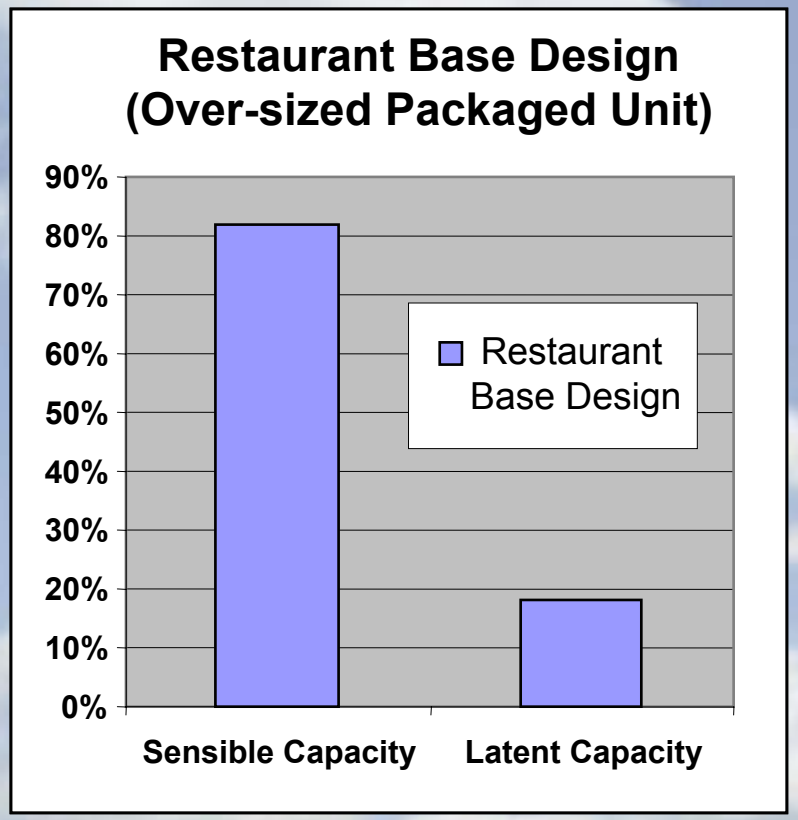
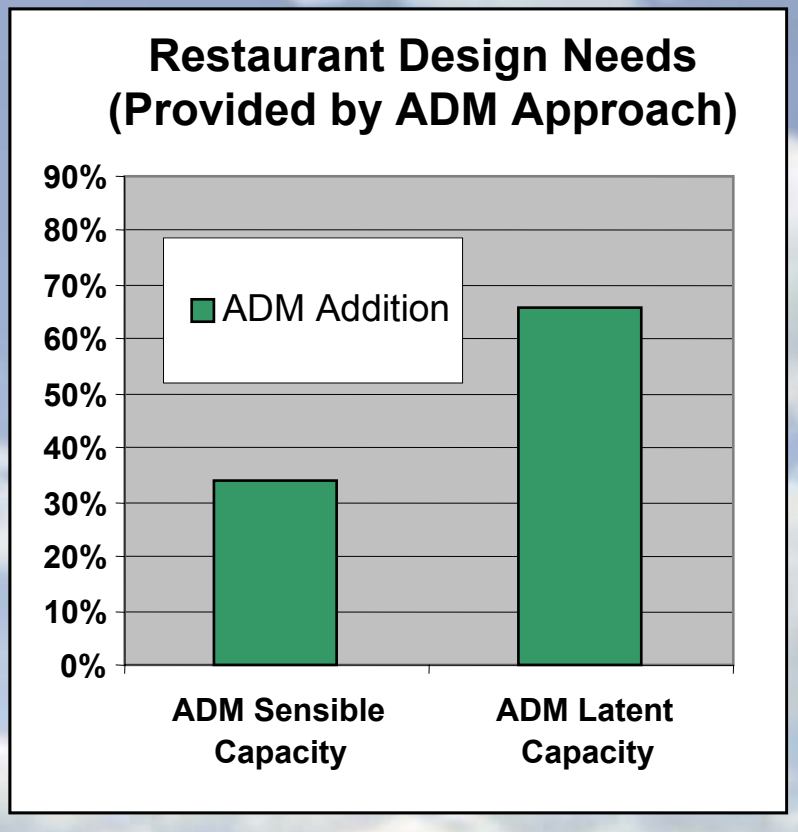
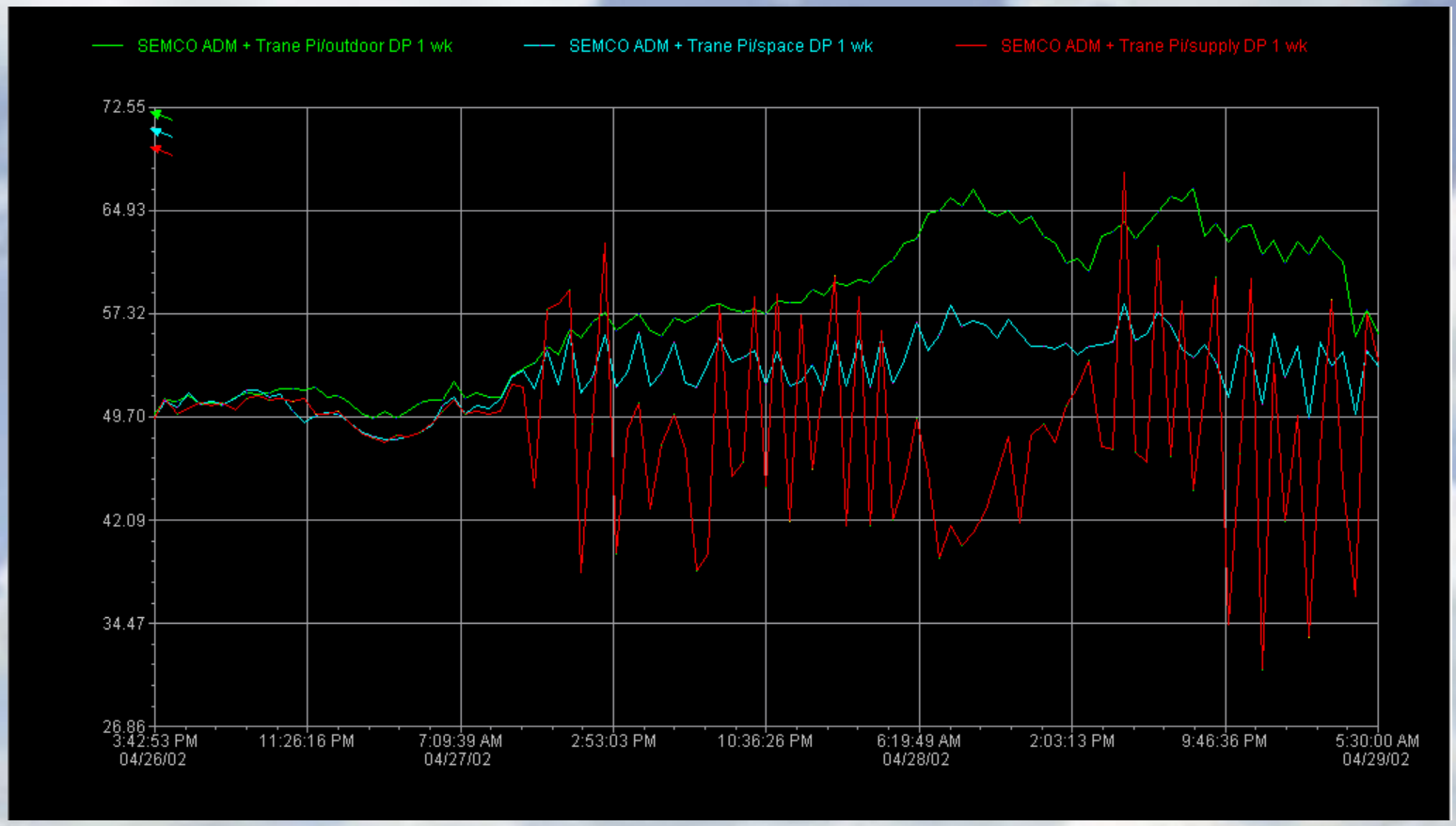
# ADM Creates a "Latent Preconditioner" Using a "Down-Sized" Packaged Unit



# ADM Delivers Low Dewpoint Air Required for Space Conditioning

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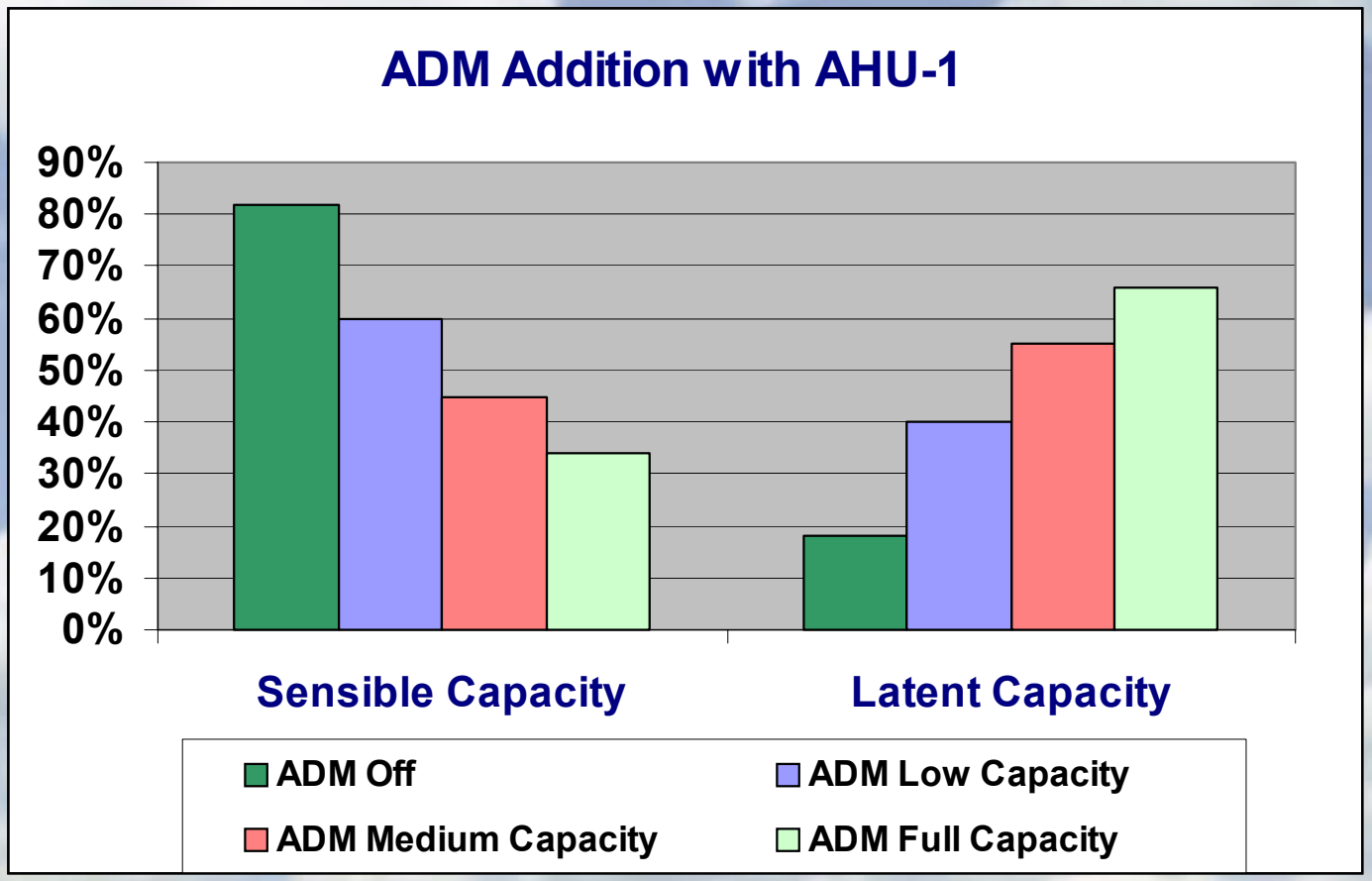
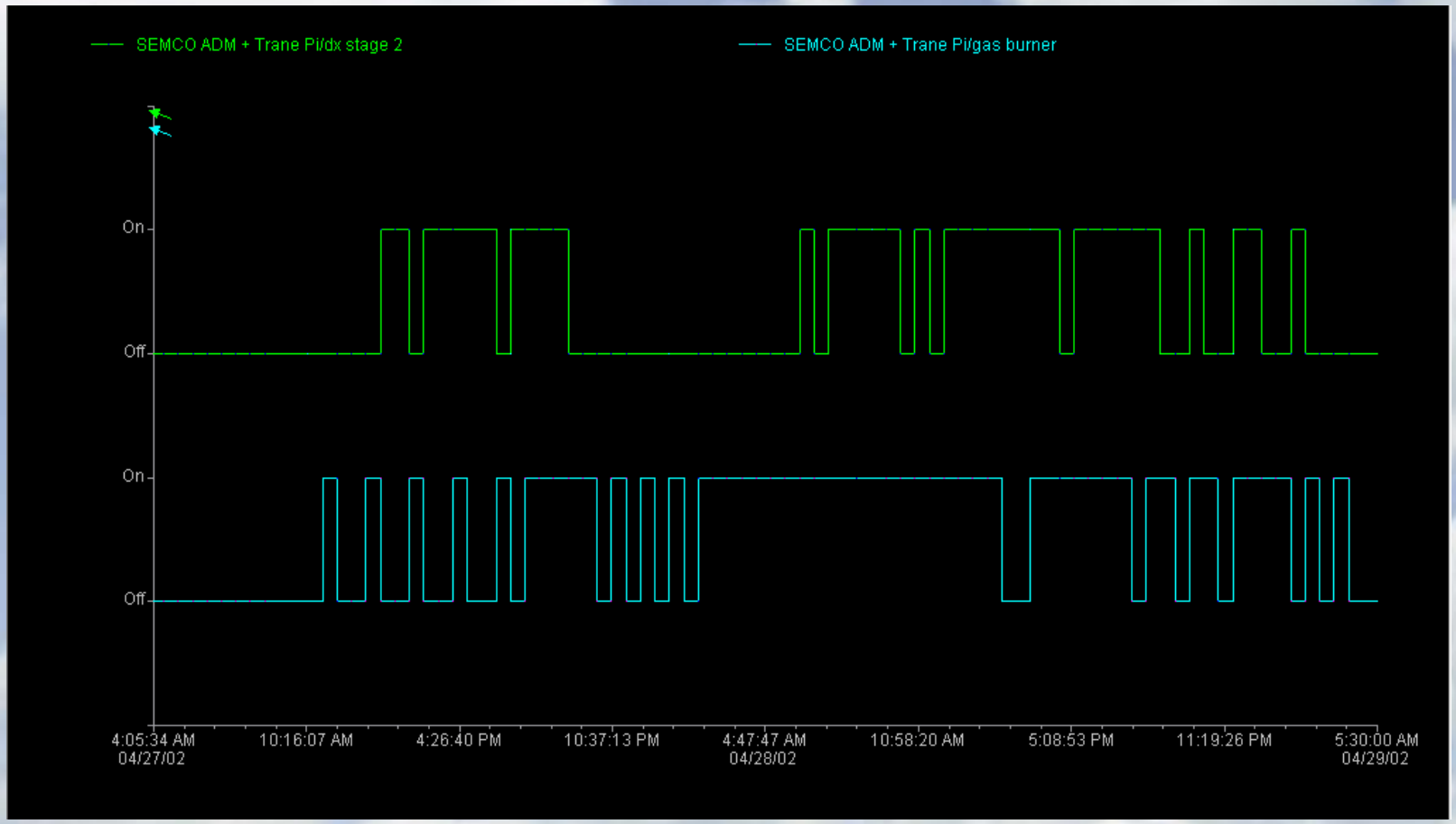
# With Modulation the ADM Can Vary the Sensible and Latent Capacity Delivered



# Control Options to Match Space Loads



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